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Seismic evidence for the erosion of subglacial sediments by rapidly draining supraglacial lakes on the West Greenland Ice Sheet

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As part of a multi-disciplinary, multi-national project investigating the ice-dynamic implications of rapidly draining supraglacial lakes on the West Greenland Ice Sheet, we have conducted a series of seismic reflection experiments immediately following the rapid drainage of Lake F in the land-terminating Russell Glacier catchment to [1] isolate the principal mode of basal motion, and [2] identify and characterise the modification of that mode as forced by ingress of surface-derived meltwaters. Lake F had a surface area of $\sim$3.84 km^2 and drained entirely in less than two hours at a maximum rate of $\sim$ 3300 m^3 s^{-1}, marked by local ice extension and uplift of up to 1 m.

Two seismic profiles (A and B) were acquired and optimised for amplitude versus angle (AVA) characterisation of the substrate. All seismic data were recorded with a Geometrics *GEODE* system, using 48 vertically-orientated 100-Hz geophones installed at 10 m intervals. 250 g pentalite charges were fired in shallow auger holes at 80 m intervals along each line, providing six-fold coverage. Profile A targets the subglacial hydrological basin into which the Lake-F waters drained, and reveals a uniform, flat glacier bed beneath $\sim$1.3 km of ice, characterised by the presence of a very stiff till with an acoustic impedance of 4.17 $\pm$ 0.11 x 10^6 kg m^{-2} s^1 and a Poisson's ratio of 0.06 $\pm$ 0.05. In profile B, to the southeast of Lake F in an isolated subglacial hydrological basin, ice thickness is 1.0-1.1 km and a discrete sedimentary basin is evident; within this feature, we interpret a stratified subglacial till deposit, having lodged till (acoustic impedance = 4.26 $\pm$ 0.59$\times$10^6 kgm^{-2} s^{-1}) underlying a water-saturated dilatant till layer (thickness $<$2 m, Poisson's ratio $\sim$ 0.5).

We hypothesize that the nature of subglacial till beneath the two profiles is influenced by the access of water drained from Lake F. Soft till was only identified beneath profile B, within a subglacial basin that is hydrologically isolated from supraglacial water from Lake F. Soft till was absent beneath profile A, and we suggest that the subglacial environment is only conducive to the preservation of stiffer till given the transit of large water volumes. Our observations imply that together, the many rapid lake drainages on the West Greenland Ice Sheet have the potential to influence the subglacial sedimentary regime, thereby modifying subglacial dynamic conditions.